

Remarks

Independent claims 1, 5, and 10 are amended to more clearly define the methods for making oxides of several metals with uniformly distributed metal elements, including metal doped lithium nickel oxides.

Each of these method claims is amended to state that the body of water soluble, crystalline, water containing, oxygen containing inorganic acid salt compounds is heated with microwave radiation to remove water from the crystals. This method of internally heating hydrated crystals better assures that the liquid water separated from the crystals remains with the resulting anhydrous crystals for dissolving or dispersing them to obtain a more uniform distribution of the metal elements. The microwave heating practice is described in paragraph 0026 of the specification and was used in each of the four examples set forth in the specification. Each of independent method claims 1, 5, and 10 was also amended to state that the liquid water is later removed from the mixture of metal acid salt compounds using reduced pressure of the atmosphere over the mixture. This reduced pressure or vacuum desiccation practice is described in paragraphs 0027 and 0028 of the specification and was also used in the four illustrative examples.

Claims 5 and 10 are also amended to delete the phrase "LiNiO₂ type." That phrase had been included in the original independent claims 5 and 10 to indicate that the number of nickel atoms plus dopant atoms in the crystalline product material was substantially equal to the number of lithium atoms, and that the crystal structure of the product was like that of LiNiO₂ (for example, see paragraph 0031). However, original claims 5 and 10 have been rejected under 35 U.S.C. 112, second paragraph, as being indefinite because of the inclusion of the deleted phrase. The Examiner is requested to remove this rejection.

Claims 1-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Mitate (5,985,488). The Examiner is respectfully requested to reconsider and remove this rejection of claims 1-11 for the following reasons.

Applicants' claimed methods are capable of producing very uniform mixtures of several metal elements combined in crystalline metal oxide powder material. The methods are very useful in making crystalline lithium-containing and nickel-containing oxide materials that are uniformly doped with relatively small amounts of two or more additional metallic elements

such as $\text{Li}_{1.0}\text{Ni}_{0.7}\text{Co}_{0.1}\text{Ti}_{0.075}\text{Mg}_{0.075}\text{Al}_{0.05}\text{O}_2$, $\text{Li}_{1.0}\text{Ni}_{0.7}\text{Co}_{0.15}\text{Ti}_{0.1}\text{Mg}_{0.05}\text{O}_2$, and $\text{Li}_{1.0}\text{Ni}_{0.7}\text{Co}_{0.2}\text{Mg}_{0.05}\text{Al}_{0.05}\text{O}_2$. As demonstrated in Applicants' specification, these multi-metal containing oxide materials have utility in lithium-ion type batteries when the several metals can be uniformly distributed in the synthesized crystalline material.

The methods of claims 1-11 use water soluble, crystalline, water containing, oxygen containing inorganic acid salt compounds of at least two of the metals to be incorporated in the crystalline metal oxide powder product. The use of metal nitrates or nitrites is preferred as recited in dependent claims 2-4, 7-9 and 11. The methods make use of the water contained in the inorganic acid salt crystals of the starting material to dissolve or disperse the then anhydrous inorganic salts to obtain a uniform mixture of the metal elements. The water is separated from the hydrated crystals at relatively low temperatures (about 100-120°C, see paragraph 0027) using microwave radiation.

The metal compounds can be carefully dissolved or dispersed in the separated water at relatively low temperatures. Following such dispersion of the metal compounds, the water is suitably removed from the liquid mixture by reducing the pressure of the atmosphere over the liquid and heating the mixture. This vacuum desiccation step can help stir the mixture and it reliably yields a dry material for calcination in which metallic elements have been mixed. The dried mixture is then calcined to form the mixed metal oxide product. The evolution of nitrogen oxides does not adversely affect the metal oxide product.

The Mitate et al '488 patent (hereafter Mitate for brevity) does not teach or suggest the methods of claims 1-11 for using the water of crystallization from two or more metal inorganic acid salts to obtain a native liquid for close-to-ambient temperature mixing of the metal constituents.

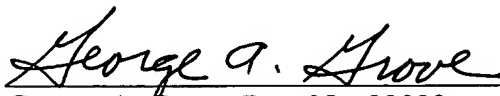
Mitate mixes lithium compounds, nickel compounds, and third component compounds to make lithium nickel oxide based electrode materials. But the compounds are selected so as to obtain melting at temperatures of the order of 300°C. A very large number of such compounds are listed over columns 5-12 of the Mitate specification. Some, only a small portion, of the compounds are inorganic acid salts and only some of these are hydrated. But Mitate does not teach or suggest a method of making oxides of uniformly mixed metals in which water soluble, crystalline, water containing oxygen containing inorganic acid salts of the metals are used so as to carefully extract liquid water from the crystal structure of initially hydrated salts

and using the liquid water at low temperatures to disperse the remaining anhydrous metal salts (and optionally TiO_2).

Where Mitate obtains low temperature "melting" with hydrated precursors in Examples 201-205, 211-216, he proceeds immediately to preliminary calcination at 400-500°C and calcining at 700°C. Mitate provides no teaching or suggestion of removal of crystal containing water by internal heating with microwave radiation. And Mitate provides no teaching or suggestion of subsequent removal of the water under reduced pressure with heating to assure thorough mixing of diverse quantities of metal atoms for a uniform metal oxide product material. Accordingly, it is respectfully requested that the rejection of claims 1-11 as unpatentable over Mitate be reconsidered and removed.

Claims 1-11 should be allowed and the case passed to issue.

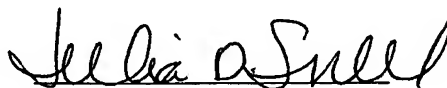
Respectfully Submitted,



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